Executive Office of Energy and Environmental Affairs
Office of Technical Assistance and Technology

Water Conservation Fact Sheet

Overview of Water Conservation Techniques and Resources for Massachusetts Industries

OTA Water Conservation Services
The Office of Technical Assistance and Technology (OTA) offers a range of assistance and information services to help facilities improve water use efficiency, comply with federal and state regulations, reduce wastewater discharges and implement effective water conservation measures. These services include site visits to facilities, workshops, and publications, such as a list of best management practices for industries and case studies that highlight successful water conservation practices. For more information, please visit our website:
http://www.mass.gov/envir/ota/resources/water_conserv.htm

Introduction

Water has long been considered a utility item to be accounted for as a general overhead expense of production. Since water has become a limiting resource for economic development, and the costs of using and heating water continue to rise, it is important to treat water as one of the raw materials for production. Water is a resource that has to be managed properly, and can help save money – water conservation projects can have payback periods as short as a year or less. This fact sheet is designed to help facilities identify and implement water conservation measures.

Getting Started – Develop a Water Conservation Strategy

Two key elements in any water conservation effort are assembling a water conservation team and benchmarking water use. Strong support and continuous oversight of the project by management will make any conservation effort more successful. The water team should include a coordinator and employees representing all areas involved in water procurement, use, and discharge, such as production, maintenance, wastewater treatment operations, and finance staff. The team should evaluate water use, identify conservation opportunities, and develop a plan to implement chosen measures.

The next step of a water conservation program is to quantify water use. Water use can be divided into three main areas – process, sanitary, and landscaping. Conducting a water balance can help to identify all water use areas. In the survey of any major use areas, the water team should measure the flow/use rates and the physical and chemical conditions (temperature, color, suspended solids, type and composition of dissolved materials, etc.) of the water, as well as wastewater leaving the area, leaks, and potential losses due to evaporation. Flow meters should be used to quantify water use for each product line or piece of equipment if possible, because this will help to demonstrate the true cost of manufacturing each product. Details such as cost of energy for heating and/or cooling water should also be included in this accounting. Regularly monitoring water use will enable you to track successes and continue to identify areas for water conservation opportunities.

Identify Water Conservation Opportunities

The primary goal of the water conservation team should be to reduce unnecessary water consumption and to redirect flows where chemical and physical properties are conducive to reuse. Soliciting employee suggestions can be helpful in identifying areas where water is wasted or could be reused. Information on water conservation is available through vendors, trade associations, consultants, and state and federal agencies.

Water Conservation in Industrial Operations

Water is a raw material that can be incorporated into products or used in processes for cooling, washing, or as a carrier. The sections that follow detail water conservation options that are common to many industrial operations.

Recovery for Reuse

Reusing process water in another area with less stringent water quality requirements can be a cost-effective option.

- Hard-pipe used water streams from wastewater treatment to other production areas where the chemical and physical properties of the water are compatible.
- Design a system to collect, treat, store, and reuse water as an integral part of operations. Simple filtration and/or separation systems can be implemented to make water compatible for reuse.
- Reuse final rinse water for initial cleaning in batch operations.

Rinsing

A major industrial use of water is for rinsing. Improving rinse tank design, sizing tanks properly, evaluating alternative rinse tank configurations, and utilizing available control techniques can help to minimize wastewater generation from rinsing operations.

- Utilize spray rinses with fog or atomizing nozzles instead of bath or flood rinses.
- Employ multiple tank countercurrent rinsing techniques, which can reduce water consumption by up to 90% compared to conventional single-stage rinse systems.
- Allow sufficient time for dripping or employ an air-knife to reduce dragout from cleaning tanks to rinse tanks.
- Optimize water flow to rinse tanks by installing conductivity, pH, or turbidity meters or other contaminant measuring devices; only add water when the contaminant level reaches a set level.
- Use air, ultrasonic, or mechanical agitation to improve efficiency of rinsing operations.
- Switch from continuous to on-demand rinsing by using motion sensors or programmable logic controls.
- Select the minimum sized tank appropriate for all parts/products.

General

- Educate employees; change water use culture.
- Utilize non-chemical/non-aqueous cleaning methods where possible. These could include:
  - Low or no water clean-up – mop, sweep, squeegee, or brush to pre-clean
  - Vacuuming
  - Blow-off
  - Steam cleaning
- Install water-saving fixtures where possible.
- Have a routine maintenance program for leak identification and repair.
- Turn off all water-consuming equipment when not in use.
- Install flow restrictors.
- Plan in advance for restrictions on water use, addressing both process water and outdoor watering
- Use employee incentives – reward employees for identifying ways to reduce water use.

Non-Contact Cooling Water

Non-contact cooling water is used in a production process for cooling the equipment, process, or product. Typically, contaminant concentration is low and the water can be reused many times.

- Install a recirculating (closed-loop) cooling system.
- Recycle non-contact cooling water through a chiller or cooling tower for reuse.
- Insulate cold water piping.
- Check entering and exiting water temperatures to ensure they are within the manufacturer's recommendations. If possible, set the water flow rate near the minimum required by the manufacturer.
- Regularly clean heat exchange coils.
- Many reuse cycles may necessitate use of biocides to address biological growth; biocides may have wastewater discharge permit implications.

Steam Systems

Water use by boilers will vary with boiler size, steam use, and condensate return. Proper use and maintenance of boilers will reduce water use.

- Develop a regular inspection and maintenance schedule for steam traps, steam lines, and condensate pumps.
- Ensure proper water treatment to prevent corrosion.
- Install a condensate return system.
- Automate the blowdown system based on conductivity measurements or concentrations of total dissolved solids (measured as conductivity, pH, silica or phosphate).
- Automate chemical feed system(s).

Cooling Towers

- Develop and implement a scale, corrosion, and bio-fouling protection plan.
- Determine whether cooling towers are appropriately sized for the cooling load.
- Reuse water from other areas as make-up water.
- Regularly maintain and clean evaporative surfaces.
- Utilize automatic controllers to monitor the concentrations of dissolved solids and pH and bleed or add chemicals as necessary.
- Evaluate drift losses. If excessive, install drift eliminators or repair existing equipment.
- Minimize blowdown by increasing the concentration ratio.
- Utilize mechanical water treatment to increase cycles of concentration.

Systems and Technologies to Save Water

Advanced technologies can result in substantial water and financial savings for certain high volume and/or high purity applications. These technologies include:

Closed-Loop/Zero Discharge Systems

If facilities are facing limited water supplies and/or limited discharge capacities or if the stability (thermal, ionic, etc.) of the incoming water stream is crucial to operations, a closed-loop system may be a technically and economically viable option. The technologies for a closed-loop system may include membrane filtration, deionization beds, or reverse osmosis. Closed-loop systems greatly reduce fresh water needs, as well as the load on the local wastewater treatment facility. It is possible that a closed-loop system can increase energy consumption and generate sludges which will be subject to hazardous waste regulations. However, such systems can offer significant quality and productivity improvements by providing a reliable stream of contaminant-free water. Closed-loop systems are best considered at the planning stages for a new line or facility.

Clean-in-Place Systems (CIP)

CIP systems are typically automated systems that clean the interior surfaces of pipes, vessels, process equipment, and associated fittings without disassembly. Modern CIP systems have evolved to include fully automated systems with programmable logic controllers, multiple balance tanks, sensors, valves, heat exchangers, data acquisition and specially designed spray nozzle devices. CIP systems can be made and operated to optimize the use of water, solvents, chemicals, and other materials that are used to clean process equipment.

Efficient Membrane Filtration Systems

Simple bag filtration (down to 3 microns and higher) can yield water that can be reused for the same process or other processes. When soluble contaminant levels are high, or high-quality water is required, sophisticated and expensive filtration systems that use micro-, ultra-, or nano-filters or reverse osmosis to treat wastewater can be utilized. Industries that require high purity water often employ such systems for water reclamation. Like closed-loop systems, membrane systems increase energy consumption due to pump use, and the removed solids and filters may pose waste management compliance issues.

Reclaimed Water

Reclaimed water is wastewater that has been treated at a wastewater treatment plant so that the water can be used again for various applications excluding drinking water. The use of reclaimed water will reduce the pressure on the existing water supply. The Massachusetts Department of Environmental Protection (MassDEP) has interim guidelines on reclaimed water, on its website at http://mass.gov/dep/water/reuse.pdf. MassDEP is currently drafting regulations that will allow increased uses of reclaimed water.

Facilities close to their local wastewater treatment plant may want to explore the use of reclaimed water, after consultation with MassDEP, the Department of Public Health and the local board of health. It will also be necessary to ensure compliance with the state plumbing code.

Energy and Water

Moving and heating water requires large amounts of energy. While some of this energy can be reclaimed through the use of heat exchangers, reducing water consumption will reduce corresponding energy demands. In addition, sizing both heating and cooling systems appropriately, based on necessary loads, will reduce water consumption in boilers and cooling towers. Conducting both water and energy audits will help to optimize your facility's use of these resources. Information on energy conservation measures is available on OTA's energy conservation web site - http://www.mass.gov/envir/ota/resources/energy_conserv.htm.

Sanitary

While sanitary water use may comprise a small percentage of water use, it still presents opportunities for conservation. In addition, these changes may help to remind workers about the company's overall efforts on water conservation:

Toilets

- Replace older toilets with more efficient models or install dual-flush adapters.

Urinals

- Replace with new, ultra-low-flush or non-water using models.
- Retrofit siphonic jet urinals by installing timers.

Faucets

- Retrofit with aerators or flow restrictors.
- Replace older faucets with models designed to curb excessive use (automatic on and off self-closing and infrared and ultrasonic faucets).

Showers

- Retrofit with aerators, flow restrictors, or low flow showerheads.

Landscaping

Water that is used for maintaining landscapes and lawns should be used in a manner that minimizes such use through the implementation of water conservation and water efficiency practices. The following water conservation practices are commonly applied to outdoor lawn watering:

- Minimize area of lawns or landscapes to be watered.
- Use low water-use/drought-resistant landscaping techniques.
- Irrigate efficiently by limiting the number of watering days per week or per month; watering only when necessary; and avoiding watering during precipitation events, in windy conditions and during the hottest part of the day (8am to 6pm).
- Maximize water efficiency of automatic irrigation systems by conducting regular irrigation audits, installing equipment such as moisture sensors, rain shut-off devices, and climate-based controllers, and properly operate and maintain automatic irrigation systems.
- Minimize use of potable water and groundwater through reuse of stormwater

Additional guidance on techniques for reducing water demand associated with landscaping and outdoor lawn watering is available in the Massachusetts Water Conservation Standards.

Industry Resources

Different industries employ specialized processes to recover or reuse process water. OTA has published several guidance documents and case studies that highlight water conservation opportunities:

Water Conservation Best Management Practices (BMP): http://www.mass.gov/envir/ota/resources/waterbmp.htm
BMP for Semiconductors: http://www.mass.gov/envir/ota/resources/waterbmp.htm#semiconductors
BMP for Metal Plating: http://www.mass.gov/envir/ota/resources/waterbmp.htm#metal
BMP for Printed Circuit Boards: http://www.mass.gov/envir/ota/resources/waterbmp.htm#circuit
BMP for Paper: http://www.mass.gov/envir/ota/resources/waterbmp.htm#paper
BMP for rubber and plastics: http://www.mass.gov/envir/ota/resources/waterbmp.htm#rubber
OTA Water Conservation Case Studies: http://www.mass.gov/envir/ota/publications/case_studies2.htm

References

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- North Carolina Division of Pollution Prevention and Environmental Assistance -- http://www.p2pays.org/water/
- Greening EPA: Top 10 Water Management Techniques. US EPA: http://www.epa.gov/greeningepa/water/techniques.htm
- Vickers, Amy, "Handbook of Water Use and Conservation", Amherst, MA, Water Plow, Press, 2001.
- http://www.p2pays.org/ref/01/00139.htm#Efficiency
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- http://p2pays.org/ref/04/03097.pdf
- http://www1.eere.energy.gov/femp/water/water_bmp6.html
- Metal Finishing: http://www.nmfrc.org/bluebook/sec27.htm
- Pulp and Paper: Panchapakesan, B. "Closed White Water System Designs", *Environmental Issues and Technology in the Pulp and Paper Industry,* A TAPPI PRESS anthology of Published Papers, 1991 - 1994
- Massachusetts Water Conservation Standards: http://www.mass.gov/envir/mwrc/pdf/Conservation_Standards.pdf

The Office of Technical Assistance and Technology (OTA) has developed a series of fact sheets on Resource Conservation practices and issues. To see the other fact sheets please visit: http://www.mass.gov/envir/ota/publications/fact_sheets.htm. OTA is a non-regulatory office within the Executive Office of Energy and Environmental Affairs (EEA) - http://www.mass.gov/envir/ - that provides a range of assistance services to help businesses cut costs, improve chemical use and energy efficiency, and reduce environmental impact in Massachusetts. For further information about water conservation, or about OTA's technical assistance services, contact:

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